AD NUMBER
ADC955799
CLASSIFICATION CHANGES
TO: **UNCLASSIFIED**
FROM: **CONFIDENTIAL**
LIMITATION CHANGES
TO: **Approved for public release; distribution is unlimited.**
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Critical Technology; 22 OCT 1987. Other requests shall be referred to Naval Air Development Center, Warminster, PA 18974. This document contains export-controlled technical data.**
AUTHORITY
NAWCAD memo dtd 26 Aug 2016; NAWCAD memo dtd 26 Aug 2016

UNANNOUNCED

SECRET

CONFIDENTIAL

COPY 39

U. S. NAVAL AIR DEVELOPMENT CENTER

JOHNSVILLE, PENNSYLVANIA

Anti-Submarine Warfare Laboratory

REPORT NO. NADC-AW-N6207 3 MAY 1962

TECHNICAL NOTE
AIRBORNE INFRARED OCEANOGRAPHIC MAPPING (U)

P. M. Moser

WEPTASK NO. RUDC4B000/2021/F001-05-002
Problem No. 204

C&H

DO NOT DESTROY!

CONFIDENTIAL

PLATE NO. 11569
4ND-NADC-5213/5

SECRET

~~CONFIDENTIAL~~
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION ~~CONFIDENTIAL~~	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION / AVAILABILITY OF REPORT Distribution limited to U.S. Government agencies and their contractors; Critical Technology; 22 Oct 1987
2b DECLASSIFICATION / DOWNGRADING SCHEDULE Downgraded at 12-Yr Intervals; Not Automatically Declassified DoD DIR 5200.10	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) NADC-AW-N6207	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Naval Air Development Center	6b OFFICE SYMBOL (If applicable)
7a NAME OF MONITORING ORGANIZATION Bureau Of Naval Weapons (RUDC-43)	
6c. ADDRESS (City, State, and ZIP Code) Johnsville, Warminster, PA 18974	7b. ADDRESS (City, State, and ZIP Code) Department of the Navy Washington, 25 DC
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b OFFICE SYMBOL (If applicable)
9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.
	WEPTASK RUDC4B000/2021 F001-05-002	Prob. 204	

DTIC ELECTE NOV 2 1987 S D

11. TITLE (Include Security Classification)
Airborne Infrared Oceanographic Mapping (U)

12. PERSONAL AUTHOR(S)
P.M. MOSER

13a. TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Technical Note	FROM May 1959 TO May 1962	1962 May 3	17

16. SUPPLEMENTARY NOTATION
Transcript of a talk given on 7, 9, 15 and 30 November 1961

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

Submarine	Antisubmarine	Surface Effects	Propagation
Wake	Infrared	Sea Surface	Thermal Front
Detection	Airborne	Underwater Sound	Nonacoustic

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

(C) WEPTASK RUDC4B000/2021/F001-05-002, Problem Assignment No. 204 was established to perform studies, establish equipment characteristics, procure equipment and conduct technical and flight evaluations of modified passive infrared line scan surveillance systems to determine their capability for detecting surface wakes generated by the passage of submerged submarines from fixed-wing aircraft. This report provides a semi-quantitative description of results of obtained during overwater flight trials of the AN/AAD-2 infrared line scanner. Infrared imagery of surface effects produced by submarines operating on the surface, while snorkelling, at periscope depth, and at 100-ft depth (but positively buoyant) is presented. Imagery of ships suggests use of passive infrared imaging devices for nighttime detection and classification of surface vessels. Imagery of the surface expression of natural bulk sea temperature structures suggests the use of thermal mapping devices as adjuncts to sonar for inferring acoustic propagation characteristics.

DTIC COPY FURNISHED TO

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT	21 ABSTRACT SECURITY CLASSIFICATION
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	~~CONFIDENTIAL~~

22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code)	22c OFFICE SYMBOL
PAUL M. MOSER	(215) 441-1873	50C

DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

*U.S. Government Printing Office: 1985-507-047

~~CONFIDENTIAL~~

TECHNICAL NOTE
AIRBORNE INFRARED OCEANOGRAPHIC MAPPING (U)

P. M. Moser

One of the two primary reasons for the existence of the U. S. Navy is, in time of war, to control the use of the seas for U. S. purposes and deny their use to the enemy. Since control follows from knowledge it would be appropriate that the U. S. Navy have the clearest understanding of the seas. Yet, it has been said that more is known about the moon than is known about the oceans. With the coming of the submarine and the airplane a third dimension has been added to the former two-dimensional domain to be controlled. The U.S.S.R. has responded by a greatly increased effort in oceanographic studies---the U. S. is lagging in studies of this "inner space" in much the same manner as the studies of outer space. The surveillance of the sea: to detect, to classify, and to monitor hostile vehicles, is one of the most critical ingredients of any program of anti-submarine warfare. To find submarine targets consistently requires a far more extensive knowledge of the sea itself than currently prevails.

The group that I represent has been investigating the possibility of detecting submarines by detecting effects produced by them on the surface of the ocean. One such effect is a change of surface water temperature in the wake of a submarine due to a stirring of subsurface water of different temperature to the surface. By use of passive, airborne, infrared mapping devices, designed originally for land reconnaissance, we have been able to obtain thermal pictures of the sea surface, which under certain, not-clearly-defined conditions, reveal surface effects produced by submerged submarines. As by-products, we have discovered an interesting phenomenon that points out the value of airborne infrared imaging devices as oceanographic instruments; we have inferred a potential method of improving sonar ranges based on utilization of this phenomenon; we have inferred a potential method by which a friendly submarine may effectively shield itself against detection by sonar; we have noted that detection and partial classification of surface vessels is possible even on the darkest of nights by means of these passive devices and, finally, these latter results suggest the feasibility of a missile using an infrared guidance system to be used against surface vessels.

I should like to take you along in our P2V aircraft on a simulated submarine detection exercise with an infrared mapping device. The infrared pictures that I show you have been recorded at night and are taken from a number of our exercises.

As we pass over the beach (figure 1) at Long Branch, New Jersey en route to the operating area we note an overflow of cold, fresh water into the ocean from the Takanassee Lake reservoir and an ebbing tide drawing it to the southeast. As the aircraft advances at 170 knots at a

representative altitude of 2000 feet, our infrared device sweeps out a continuous strip map 2300 yards wide. About 16,000 relative temperature measurements---each of about 0.050° resolution---are made each second and recorded sequentially on photographic film in the form of an image such that warm areas appear light and cool areas appear dark. Typically, an area of 195 square nautical miles can be surveyed per hour---a 10-knot oceanographic vessel would require almost four months to cover an equivalent area. Furthermore, in the latter case, the complexion of the ocean surface would have changed so many times during the measurement period that only its more permanent features---such as the Gulf Stream---would be discernible. This picture (figure 2), a 7500-yard long view of the ocean off Long Branch, shows one of commonly several demarcation lines running parallel to the shore, which represent perhaps a shearing of the inshore tidal currents against permanent oceanic currents. As we cross the coastal shipping lanes, we encounter first a ship (figure 3) with three hot stacks and then one (figure 4) with one hot stack. Next we pass over a ship (figure 5) which, from its dimensions and the placement of its two stacks, appears to be a destroyer. These pictures suggest the possible utilization of a passive infrared mapping device for the nighttime detection and partial classification of surface vessels. In addition, since a hot stack serves as an excellent beacon in the intermediate wavelength portion of the infrared spectrum, perhaps a family of Sidewinder-like missiles could be developed for use against surface vessels.

Finally, we arrive in the submarine operating area and we recognize the submarine (figure 6) on the surface as a warm, stackless, rather poorly defined object against the cool sea background. We note that on this occasion and in this particular area, the oceanographic conditions are such that a finely-etched, line-like, cold wake is being generated.

On other occasions we have recorded warm wakes (figure 7) such as a submarine operating at maximum periscope depth has generated in this case. We note in this picture that the submarine has passed from a region where the surface water is cool to one where it becomes abruptly a few tenths of a degree warmer. In the cool portion the wake appears puffy; in the warm portion it appears more like a slick. We note also an apparent shearing of adjacent water masses taking place since the wake is discontinuous along the line of demarcation. If we are operating in an area where there are diverging currents we may observe a natural upwelling of water to the surface. We believe that this infrared scene (figure 8), recorded off the coast of Maine, depicts such a phenomenon. Also of interest in this picture is a 2-mile long wake of a snorkeling submarine. On the original negative it appears strikingly like an aircraft contrail against a background of clouds.

We request the submarine to operate in a positively buoyant condition at a keel depth of 100 feet at a speed of 6 knots. Then we map the area in front of the submarine (figure 9) to insure against crediting the submarine with generating any surface patterns that may be of natural origin. We see a natural background pattern which we can use as a geographical reference.

This picture (figure 10), which was recorded 13 minutes after the preceding one, shows the same area, which has now been almost completely transversed by the submarine from left to right. We see a series of what appear to be cold splashes produced on the surface by passage of the submerged submarine.

This picture (figure 11) of the same scene was recorded on the next aircraft pass 4 minutes after the preceding one. Now we see more splashes on the surface indicating the advance of the submarine. It is interesting to note that the actual position of the submarine, at the time of this recording, was about 1/2 mile beyond the line represented by the right edge of this picture. There was an interval of about 9 minutes between the time of passage of the submarine and the time of expression of the observed effects on the surface. Although we cannot say exactly what mechanisms are involved in the generation of these surface effects, we have noted in these airborne experiments, as well as in model tank experiments we have been conducting, a dependence on a vertical temperature gradient in the water. Since sonar ranges are reduced quite drastically in regions where strong gradients exist, it may be inferred that infrared wake detection could take over as the primary means of submarine detection when sonar conditions are poorest. Our submerged run has been completed and the submarine (figure 12) is now operating on the surface. Except for that part of the hull enclosing the engine rooms in its after-section, the submarine now appears cooler than the surface water---perhaps due to operating at the cooler depths; perhaps due to a decrease in temperature of the air below that of the sea. However, the most striking feature of this picture is not the submarine but the ominous-looking, striated, cloud-like structure from which it has just emerged. Let me draw an analogy between this "thermal cloud" in the ocean and a cloud in the atmosphere. Might not a submarine submerged in this "thermal cloud" be secure against sonar detection in much the same manner as an aircraft hiding in an atmospheric cloud is secure against visual detection? Now let us direct the analogy along a different line. Would it not be foolish for an interceptor aircraft to operate in a cloud deck while searching visually for an enemy aircraft? So also it may be equally unsatisfactory to operate a sonar device---whether it be on a destroyer or in a sonobuoy---immersed in one of these "thermal clouds." An airborne infrared mapping system providing thermal pictures of the ocean surface may be of considerable value in ASW operations as an adjunct to sonar.

Now our simulated exercise is completed and we head back to land. As we pass over Barnegat Bay (figure 13) we note in the water a cool region surrounded by a warmer area. Upon completion of the flight we note on a Coast and Geodetic Survey Chart of the area (figure 14) a distinct correspondence between the pattern on our thermal map and the bottom contours of the Bay.

In concluding let me express the hope that I have conveyed to you three ideas:

First, a much better understanding of our oceans is needed and airborne infrared imaging systems can serve as valuable instruments in achieving this understanding.

Second, infrared studies of the oceans and the vessels plying them can suggest many new types of military operations and weapons.

Third, infrared devices exhibit considerable potential for submarine detection in their own right as well as serving as adjuncts to others.

(b)(6)
F. M. Moser

FIGURE 1 - Infrared Picture Recorded by AN/AAD-2 of Takanassee Lake Reservoir Overflow into the Atlantic Ocean

FIGURE 2 - Infrared Picture of Ocean off Long Branch, N. J. Showing Thermal Discontinuity About 5000 Yards Offshore

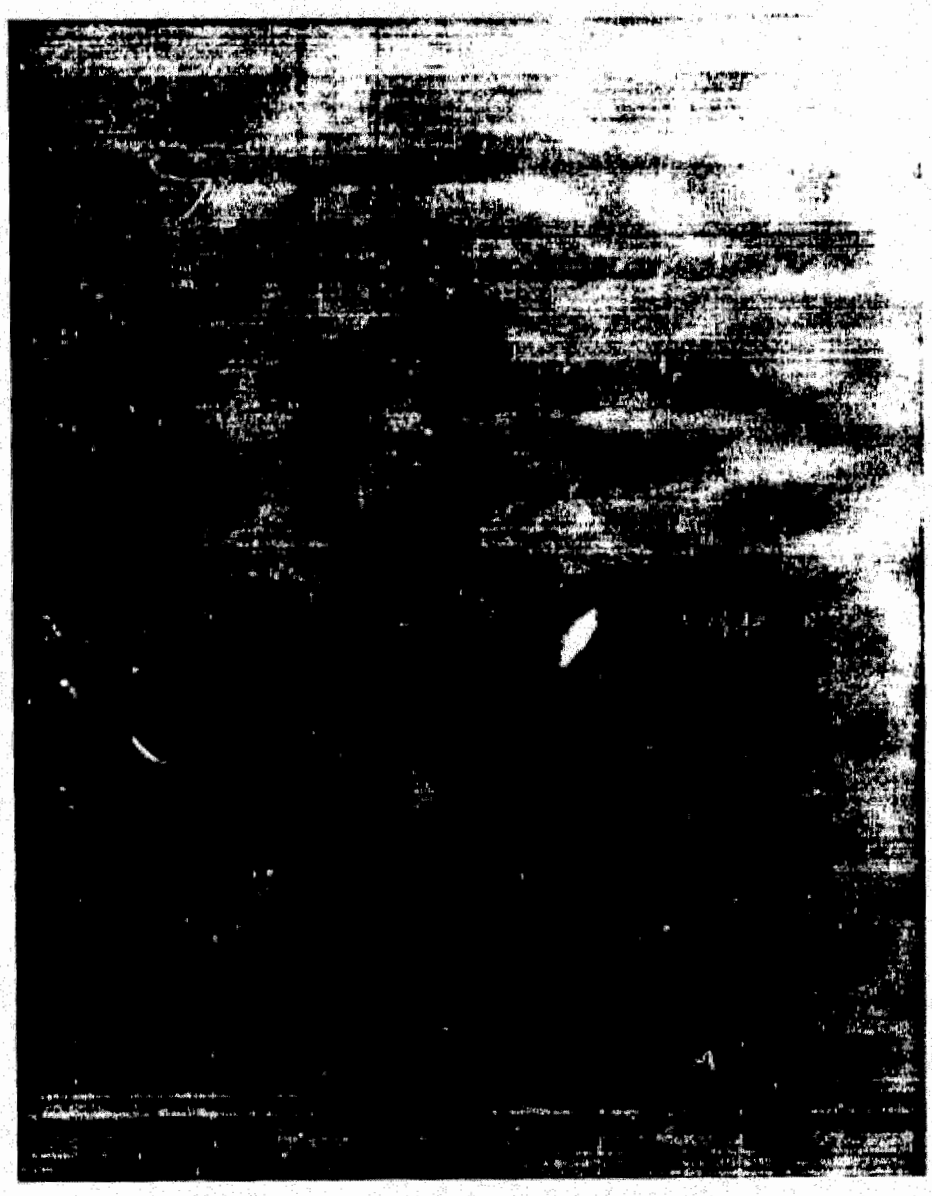

FIGURE 3 - Infrared Picture of Ship With Three Hot Stacks

FIGURE 4 - Infrared Picture of Ship With One Hot Stack

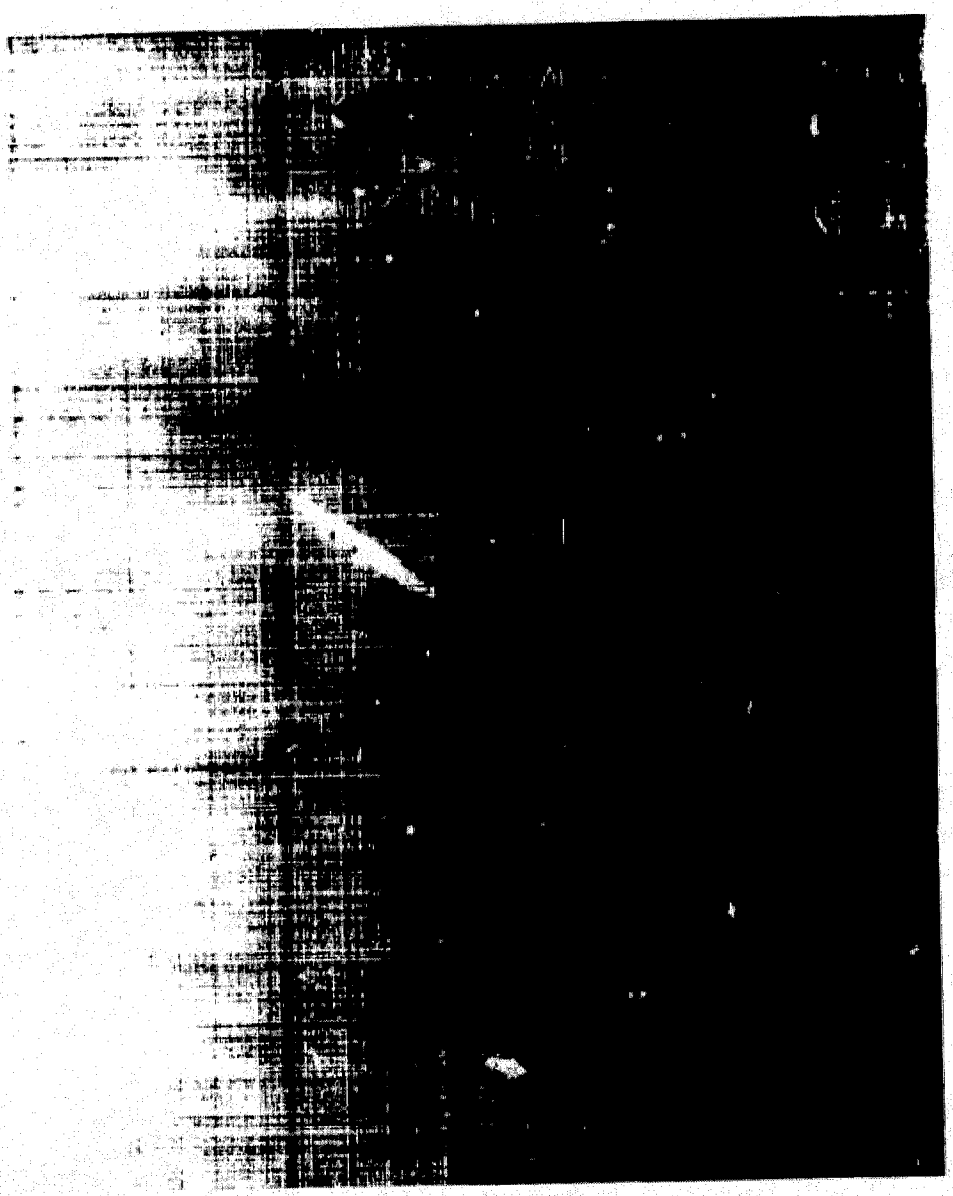

FIGURE 5 - Infrared Picture of Ship With Two Hot Stacks

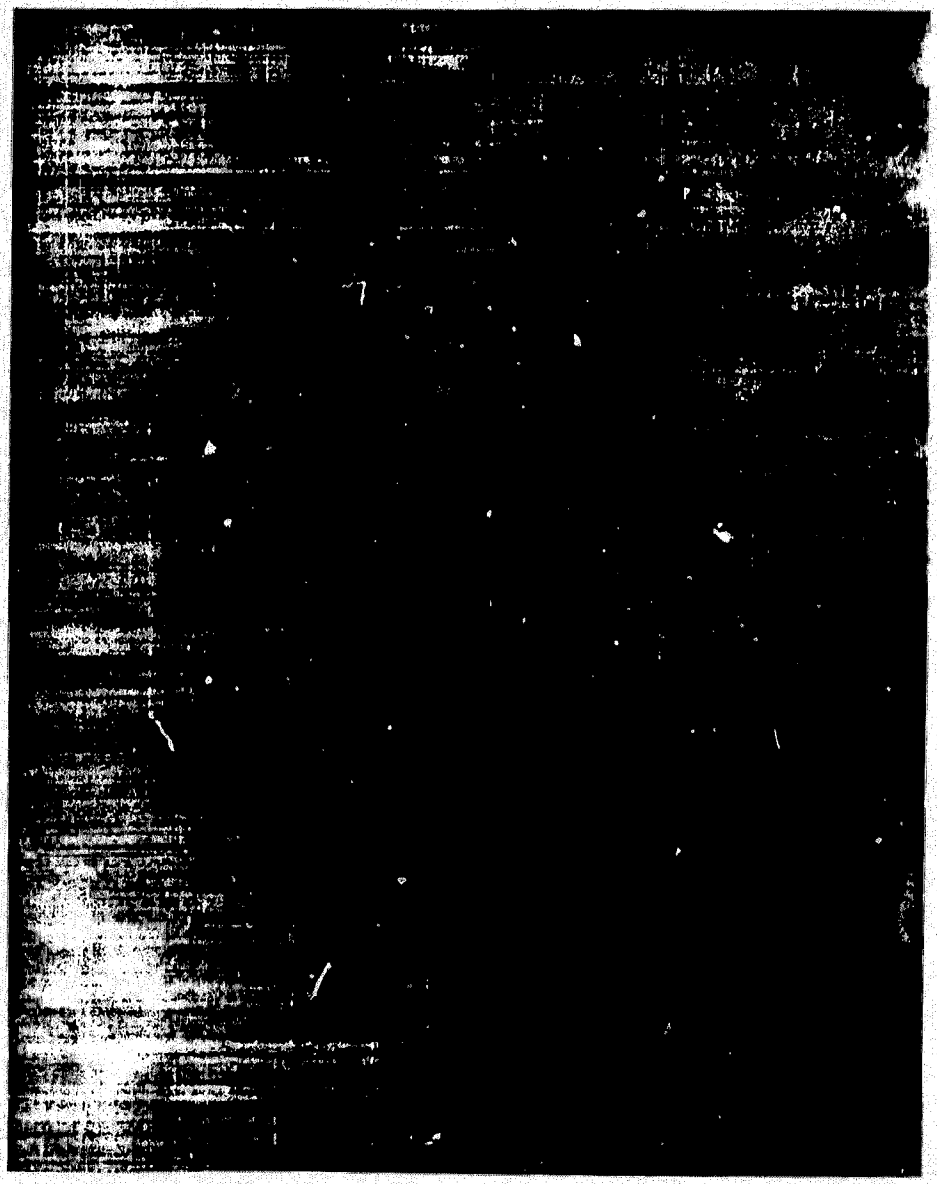

FIGURE 6 - Submarine on Surface Generating a Cold Wake

FIGURE 7 - Infrared Picture Recorded by AN/AAR-9 of a Natural Sea Surface Pattern and Warm Wake from a Submarine at Periscope Depth

FIGURE 8 - Infrared Picture Recorded by AN/AAD-2 of a Natural Sea Surface Pattern and a Cold Puffy Wake Generated by a Snorkeling Submarine

FIGURE 9 - Infrared Picture Recorded by AN/AAD-2 of Sea Surface Before Entry of Submarine into Area Shown

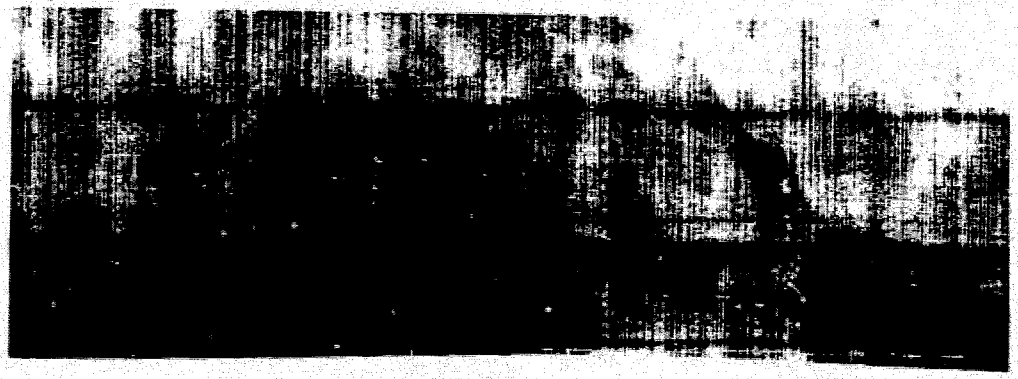

FIGURE 10 - Infrared Picture Recorded During Passage of 100-Ft Deep Submarine Through Area Shown

FIGURE 11 - Infrared Picture Recorded After Passage of 100-Ft Deep Submarine Through Area Shown

FIGURE 12 - Infrared Picture of Submarine on Surface and Natural Thermal Pattern on Ocean Surface

FIGURE 13 - Infrared Picture of Portion of Barnegat Bay

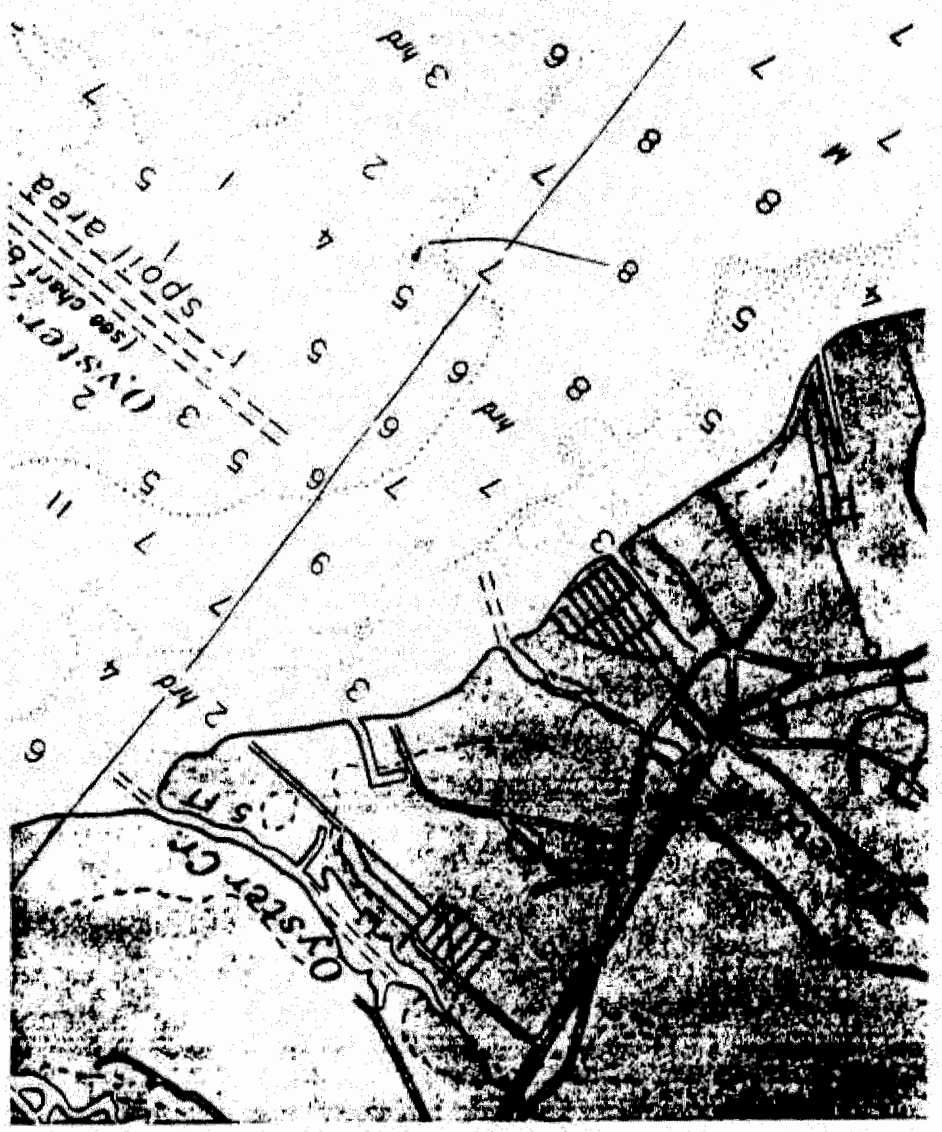

FIGURE 14 - Portion of Coast and Geodetic Survey Chart of Barnegat Bay

26 Aug 2016

MEMORANDUM FOR THE RECORD

FROM: Division Director EO & Special Mission Sensors, Avionics, Sensors and E* Warfare Dept (AIR 4.5.6

TO: Office of Counsel, Naval Air Warfare Center, Aircraft Division (NAWCAD)

Subj: SECURITY RECOMMENDAION FOR FOIA REQUEST, DON FOIA CASE FILE NUMBER 2015-008952

Ref: (a) SECNAVINST 5720.42F, DON FOIA Program, 06 Jan 99

(b) Executive Order 13526

1. Recommendation. AIR 4.5.6 reviewed each document and has the following recommendations listed by each separate document covered under the subject:

   a. Document (2) of Subj. NAVAIRDEVCEN Report No NADC-AW-N5916, 5 Jun 1959, "Submarine Wake Detection Program" (AD-C955796). Information found to be unclassified and releasable in its entirety.

   b. Document (3) of Subj. NAVAIRDEVCEN Report No NADC-AW-N5917, 8 Oct 1959, "Infrared Wake Detection" (AD-C955804). Information found to be unclassified and releasable in its entirety.

   c. Document (4) of Subj. NAVAIRDEVCEN Report No. NADC-AW-L5932, 23 Feb 1960, "Submarine Wake Detection" (AD-C955797). Portions of the report found to be classified under Section 3.3(4) under reference (b). Remaining portions of the document found to be unclassified and releasable.

   d. Document (5) of Subj. NAVAIRDEVCEN Report No. NADC-AW-L6005, 30 Mar 1962, "Submarine Wake Detection, Flight Trials of the Reconofax Camera" (AD-C955798). Information found to be unclassified and releasable in its entirety.

   e. Document (6) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6207, 3 May 1962, "Airborne Infrared Oceanographic Mapping" (AD-C955799). Information found to be unclassified and releasable in its entirety.

   f. Document (7) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6208, 8 Jun 1962, "NAVAIRDEVCEN Airborne Infrared Developments" (AD-C955801). Information found to be unclassified and releasable in its entirety.

   g. [redacted]

[redacted]

h. Document (11) of Subj. NAVAIRDEVCEN Report No. NADC-AW-N6304, 20 Jun 1963, "Use of an Airborne Passive Infrared Mapping Set for Submarine Wake Studies" (AD-338356L). Portions of the report are found to be exempted under reference (b) Section 3.3(6). Remaining portions of the document found to be unclassified and releasable.

i. Document (12) of Subj. NAVAIRDEVCEN Report No. NADC-AW-6303, 31 Jul 1963, Submarine Wake Detection, Flight Trials of the AN/AAD-2 Infrared Mapping Set in a Cessna 310-B Aircraft" (AD-340804). Information found to be unclassified and releasable in its entirety.

j. [redacted]

k. Document (14) of Subj. NAVAIRDEVCEN Report No. NADC-87161-50, 28 Oct 1987, "Applications of Airborne Passive Infrared Mapping Devices to Military Oceanography" (Reprinted from Proceedings of the First U.S. Navy Symposium on Military Oceanography, Volume II, 17-19 June 1964) (AD-C042316). Information found to be unclassified and releasable in its entirety.

l. Document (15) of Subj. NAVAIRDEVCEN Report No. NADC-AW-6421, 27 Aug-1964, "Infrared Radiation from Ships" (AD-353610L). Portions of the report found to be exempt under reference (b) Section 3.3(6). Remaining portions of the document found to be unclassified and releasable.

m. [redacted]

n. [redacted]

o. [redacted]

2. Basis of Recommendation. All information was reviewed with current class guides and what is considered open source information. Appropriate recommendations made above with respect to findings. Documents found with portions releasable were sanitized based on class guides and reference (b). Such disclosure of Department of the Navy classified information would give potential adversaries insight that would present a significant threat to national security.

3. Exemptions Utilized. Two separate exemptions were utilized in the determination of what information should be sanitized or exempted from release via Freedom of Information Act (FOIA) request process. All current Classified Military Information (CMI) has been sanitized out of the document under FOIA Exemption 3, Executive Order 13526 Sections 3.3(4) and 3.3(6). This Executive Order Section covers CMI that was originally classified over 25 years ago from date of this memorandum. Subject matter experts within AIR 4.5.6 were utilized in making the exemption determinations.

4. Point of Contact. The point of contact for this security review and recommendation is Mr. Paul W. Reimel, AIR 4.5.6 Division Director, paul.reimel@navy.mil, 301-342-0100.

8/30/2016

X Paul W. Reimel

Paul W. Reimel

Signed by: REIMEL.PAUL.W.1229241016

Distribution:

NAWCAD 7.4

NAWCAD 4.5.6